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Multi-species tests have not yet been used to any extent for regulatory purposes perhaps because standard methods have not yet been developed for them. They also, in their present state of development, do not yield data readily amenable to use in regulatory purposes. Often the results explain why an effect may occur but they are not quantitative. Multispecies tests are probably best used for fate and pathway studies and not effects studies in their present state of development.

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Scientific Problems in Using Multispecies Toxicity Tests for Regulatory Purposes

When one examines the titles of papers presented at this workshop, it becomes clear that the workshop organizers intended the subject of multiple species testing to be viewed within a regulatory framework. The impact of viewing from that perspective is not trivial. The practice of environmental toxicology, done in a manner that is useful for regulatory purposes, must start with different "givens" and use decision points that are likely to be different from those for environmental toxicology pursued for only scientific reasons.

Probably a difference that is foremost is the imperative need for regulatory toxicology to be decisive. Decisiveness often prompts the criticism that regulatory toxicology is unscientific. To so confuse the scientific approach with decisiveness is to be "unscientific". While all this may seem to be a play on words it is not and this misnomer causes grevious arguments among some scientists who do not have to be decisive.

The letter to the participants of this workshop, dated August 6, 1982, states that, "Until this is done (meaning using higher levels of biological organization than single species) it is highly unlikely that the present dependence on single species toxicity tests, though scientifically not justifiable, will be altered.". (The underlining is mine.) In my opinion this is an example of calling something unscientific when the real issue is that the level of acceptable risk is higher than the critic is willing to accept. But acceptable risk is not a scientifically made choice. I'm sure everyone here would agree that certain types of impacts can be, are and should be predicted from single species test data. Surely no one

would disagree that with reasonable confidence, the use of single species mortality data can be scientifically used to predict lethal concentrations for species making up an aquatic community. It would be foolish to use multiple species tests to determine LC50 type data. However we should not construe this statement as meaning we need LC50 data on only one species. The unmistakable implied but not stated concern of the above criticism is that more intricate impacts involving species interactions cannot be measured in single species tests. This criticism involves two issues. First, we should recognize and state what assumptions and predetermined objectives form the basis for judgments such as cited above. An assumption undoubtedly underlying the assertion is that natural type and natural functioning communities are the goal. However this is often not the regulatory goal - if it were then we would not have put-and-take fisheries, we would not stock animals except as a rehabilitation matter and we would not perform many management functions which are now commonplace, if unaltered communities were society's goal. More often than not society's goals are not the same as the assumptions an ecologist would make about what the regulatory objective is or ought to be. To be scientifically justifiable does not require selection of certain goals. For many of our surface waters, given the societal decisions that have been made about their use, single species tests may be adequate (certainly if the data are correctly applied they will be scientifically sound) for regulatory decision making. Scientific soundness or justification places no bounds on how much data or what type data are needed nor on societal goals. Any amount of data can be used in a scientifically sound way. The mere generation of data on higher levels of biological organization may or may not lead to more defensible regulatory decision making. If the letter to the participants had said that single species tests are not valid

for measuring the sensitivity of species interactions that are essential for the community well-being, then the judgment would have agreed with mine.

My assignment today is to discuss the scientific problems of using multispecies tests for regulatory purposes. I will interpret the term multispecies tests to refer to those tests in which the objective is to examine effects on inter-species interactions. If a test uses several species but evaluates the data for each species separately, I will view that as several single species tests.

First let me suggest that the scientific problems of using single and multispecies tests for regulation are to a large part identical. All of the problems of defining exposure, obtaining quality test animals, mimicking field conditions, extrapolating to other species and communities and properly assessing "wall effects" (or artifacts) are common to both. The relative importance may vary but the problems are very much the same. There is really only one reason to use multispecies tests rather than single species tests and that is if the multispecies tests provide information that single species tests do not. While I do not consider myself well versed on multispecies tests, I believe I can offer some observations that may help in sorting out the place for each.

The most obvious potential virtue of multispecies tests not possible with single species tests is the ability to measure interactions of component species that are toxicant related or toxicant affected. This has not been the objective of much of the work to date. Rather, multispecies tests have been used to determine which of several species are more sensitive. Such is a poor use of multispecies tests in my opinion because relative sensitivity of individual species can be better and more cheaply determined in single species tests. Based on my perception of the matter, whether interaction

between species that result in a community are more sensitive than the most sensitive component species is undecided as of now. Personally I fail to see how that could logically be true. If there is a convincing logic, it ought to be articulated at this workshop so its importance can be appreciated in regulatory circles.

Support for multispecies tests historically has been in part based on their greater sensitivity. Because I firmly believe that community sensitivity is only an expression of individual species sensitivity and because nearly all community functions can be adequately performed by numerous species, I would argue that the most important reason to use multispecies tests is that single species tests are likely to be too sensitive. This may not be true for those who argue that the loss or change of even one species in a community is unacceptable. I would also point out several interrelated observations about the objective we are trying to achieve with our predictive tests. First, even though acceptable community protection is achieved, society's desires might not be met if desired sport fish species are not present - especially if the desired sport fish are not indigenous. Second, some strongly support the use of community function as the basis for acceptability, however they are not willing to accept such a basis if supposedly nuisance or trash species, such as sludge worms and bluegreen algae, are performing the function. Thirdly, there is little support in many regulatory programs for concern about community structure if the recreational fishery is acceptable.

Our use of multispecies tests should be formulated with these different objectives in mind. Multispecies tests would seem to be more important where undisturbed function and structure are the goal than where a sport fishery for an introduced species is the goal.

Permit me to diverge for a moment on one aspect of goal selection - specifically the goal of ecosystem maintainence. To me the "scientific" argument for the protection of ecosystem depends on the scale we are concerned about. Clearly protection of species and functions of ecosystems on a continental or global scale are absolutely essential for human kind's well being. I do not see the protection of either as being a necessity in small stream segments or small lakes. If it is a necessity, then for the same reasons we cannot allow cornfields, Christmas tree plantations or cotton fields. There is no more reason why we must maintain complete ecosystems below every outfall than there is reason why every terrestrial plot must be a complete self-sustaining ecosystem. The arguments about maintainence of gene pools, species diversity and the like are only applicable to large scale ecosystems, not to every mixing zone or pond.

I mention this here because multispecies tests seem to me to be most useful for assuring protection of ecosystems and much less so for "managed" lakes or reaches of rivers. If so, then the societal goal may assist in deciding where and in what instances multispecies tests are most needed.

The experimental difficulty of accurately assessing impact on interactions is enormous. Undoubtedly many of these interactions involve behavior. The difficulty of making meaningful behavioral measurements in experimental conditions that can be validly applied to natural communities is much greater than measuring chemical sensitivity of single species and using it to predict toxicity.

Just because there are more species or because there are interactions between species in multispecies tests, does not per se make them more valid or more informative. In fact the reverse could well be true!

Given the difficulty of measuring impact of substances on the aquatic communities in the receiving water, a key regulatory based question is whether the refinement to be added by multispecies testing over single species testing is or can be cost effective. We accomplish little with improved testing if it cannot be correlated with impact. Any testing scheme that cannot be directly linked to an improvement for the public, will not likely be accepted by regulatory agencies. Sophisticated scientific theories and possibilities stand up in adversary proceedings even less well than do regulatory policies!

We should be sure as we evaluate the pros and cons of multispecies tests that we do not use as a base of comparison the misuse of single species data of the past. For example, practitioners of single species tests have all but ignored the very large range in relative species sensitivity that is common to many chemicals and communities. One of the false claims made for multispecies tests has been their greater sensitivity. The apparent sensitivity was not a result of species interactions at all but of having tested more species. Furthermore, greater sensitivity has no connection to greater validity!

Those who apply the results of either type test data need to give more attention to the exposure received by various components of the community. It is easy to conclude some species or groups are more sensitive when in fact they are less sensitive but have received a higher exposure. An example would be a sediment dwelling organisms and a toxicant that sorbs to the sediment. The exposure of this organism is likely to have been far beyond that of an organism living in the water column.

Multispecies tests would seem to be most valuble at our present state of knowledge, as "ticklers" to alert us that there are impacted species

interactions which could alter the community in a way that may be undesirable and which is likely to be unknown if only single species are tested. This way of using the data, i.e. to demonstrate mechanistic effects, is quite different from their use to quantitate community effects.

Excluding the use of multispecies tests to elucidate chemical-physical pathways, I see as their main advantage the potential to measure impact on species interactions that are more sensitive to toxicants than are single species or to measure community compensation that would lessen the toxicity as predicted from single species tests. I would then put the scientific problems of using these tests for regulation into two categories: 1) Show that such measurements have real world meaning, and 2) Develop written protocols and schemes for applying the data in a regulatory mode.

Multispecies tests have suffered to date from overzealous claims for their value that have not been borne out by subsequent experience. These tests should not be faulted because any test can be so misused. The notion that multispecies tests are just "little worlds" and that data from them are nearly universally applicable have given way to a more mature view. We now talk of multispecies tests in a more realistic way - i.e. to identify interactions or compensation that would be missed by single species tests.

To be accepted for regulatory use several things need yet to be accomplished. We need examples of what good judgment would say was an adequate single species data base which proved to be inadequate and where multispecies tests would have given a higher probability of correctly assessing the problem.

We also must have some generally agreed upon protocols for routine use. For a technique to be widely used, it must be moved from use as a research

tool to one that can be routinely performed by ordinary laboratories. My impression is that this step has not yet been accomplished.

Finally and most importantly, a clear rationale for applying the results to the decision making process must be laid out. How do you use multispecies test data to regulate? Just showing that a community effect has been missed or effects have been overestimated by single species tests, does not produce an answer as to how much more treatment is needed. And if it doesn't, then the knowledge will likely not be used to regulate. This brings me full circle to where I began this paper. Toxicology for regulatory use must be decisive. Up to the present, multispecies tests have been used to identify problems. We now need them to answer questions and provide solutions. Even though imperfect, rationales do exist for decisive use of single species data.

How can I better sum up my feelings than to say "multispecies tests are not yet decisive"?